

Undergraduate Thesis Prospectus

The Impact of Focused-Ultrasound and Radiation on the
Release and Transcriptome of Extracellular Vesicles in Breast Cancer
(technical research project in Biomedical Engineering)

Responses to Shortages of Healthcare Professionals in the United States
(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

What are the downstream effects of improvements in cancer therapies on healthcare?

Within the past two decades, rapid developments in early cancer detection and cancer therapeutics have improved prognosis for many patients. In the US, the cancer death rate fell 27 percent from 2001 to 2020 (CDC, 2022), and individuals 65 and older now account for 60 percent of newly diagnosed malignancies. By improving patients' health, better cancer therapies can reduce patient loads, but by increasing cancer survivability and extending lifespans, they tend to increase them, thereby stressing healthcare provision.

Impact of Focused Ultrasound and Radiation on Extracellular Vesicle Release and Transcriptome

How do focused ultrasound and radiotherapy augment the release and payload of extracellular vesicles in murine models of breast cancer?

Focused ultrasound (FUS) uses sound waves concentrated into a focal point to heat target cells. All cell types release small lipid-shelled vesicles containing payloads characteristic of the parent cell. Under the mentorship of Dr. Sheybani from the BME department at UVA, my and Emma

Imbarlina's capstone project will use focused ultrasound to optimize the release of extracellular vesicles from murine breast cancer cells. Release concentration and size of vesicles will be measured using nanoparticle particle analysis. Other *in-vitro* studies have shown that FUS alters the proteomic profile of brain cancer cells (Sheybani et al., 2020). Instead, we seek to characterize the transcriptomic profile of these vesicles to identify biomarkers of cancer using RNA-seq. We will also compare the vesicles released from FUS-treated to radiation-treated cells.

Responses to Shortages of Healthcare Professionals in the United States

By extending life expectancy, increased cancer treatment efficacy contributes to an aging population. As aged populations have a higher incidence of chronic disease, comorbidities, cognitive impairment, and other age-related health problems, they require more healthcare services. In much of the US, rural regions in particular, healthcare systems have personnel shortages (NCPF, 2009), and an aging population may soon cause demand to outstrip supply. Advocacies for the elderly, healthcare professionals, and trade associations are responding to these needs.

Primary care physicians (PCPs) serve as intermediaries between patients and specialists. Shortages of PCPs can extend patients' appointment and office wait times. Longer wait times for non-emergency services are associated with delayed treatment access, worse clinical outcomes, and patient dissatisfaction (McIntyre & Chow, 2020). Basu (2019) found that the supply of PCPs per capita declined from 2005 to 2015, due to population growth and physician retirements. This problem is exacerbated by an aging population, as people aged 65 and older make up 30-40% of primary care visits (Adams, 2002). Responses have included efforts to increase the supply and regional availability of physicians, efforts to retain practicing physicians, and to authorize a wider range of medical professionals to treat patients independently.

In the US, a physician must complete an accredited residency training program in the US or Canada to practice medicine. Of all the available residency slots in the US, however, about 99.6% were filled in 2022 (NRMP), bottlenecking the physician pipeline. Residencies are funded mostly by Medicare (CGFGME, 2014). The American Medical Association (AMA) is the largest society and lobbying group of physicians and medical students in the US. In the 1980s, evidence

indicated an impending physician surplus (Peterson, 1983). In the 1990s, the AMA responded by lobbying for fewer medical schools and limiting Medicare-funded residency slots, provisions achieved in the Balanced Budget Act of 1997 (Cooper, 2004). A political watchdog group found that the AMA topped the spending list of lobbying groups during the first half of 1997 (All Politics, 1998). In a joint statement, the AMA and five other medical associations called for a limit to public spending on doctor training (Pear, 1997). Since the Balanced Budget Act, the cap has been raised only once, when an additional 1,000 Medicare-funded slots were approved as part of the Consolidated Appropriations Act of 2021 (CMS, 2021). Today, the AMA has reversed its position, and maintains that the Centers for Medicare and Medicaid Services “should expand the residency funding cap at institutions where residents must extend their training” (AMA, 2020a). The American Hospital Association, a trade association representing hospitals and healthcare providers, favors rescinding the cap on residency slots and visa relief that would permit foreign-born healthcare workers to stay in the US (AHA, 2021).

AARP (formerly the American Association of Retired Persons), is an advocacy for individuals older than 50. Dues are \$16 a year; in return, AARP members receive discounts for travel, insurance, and other services. AARP backed the establishment of Medicare (Senate Committee on Labor, 1960) and the Affordable Care Act (Obama, 2009). Telehealth can alleviate the physician shortage in rural areas. In its statement of priorities for the 2022 legislative session, AARP Connecticut included telecommunications and telehealth as priorities (Humes, 2022).

To relieve physician shortages, AARP has also supported the independence of mid-level providers, such as nurse practitioners (NPs) and physician’s assistants (PAs). AARP’s Public Policy Institute Experts oppose rules that require NPs to contract with physicians before practicing, arguing that “removing these and other restrictions ... would enlarge the pool of

skilled clinicians who could provide people with much-needed care” (Quinn et al., 2020). AARP urged governors to rescind such rules to help healthcare systems meet the surge in demand due to the COVID-19 pandemic, and several states have temporarily relaxed the restrictions (Quinn et al., 2020). The AMA, however, opposes such expansions of mid-level provider independence. Condemning the expansions as “scope creep,” the AMA led an online campaign with the #StopScopeCreep hashtag. The campaign accuses NPs and PAs of attempting to “expand the scope of their practice” (2020b). The president and CEO of the American Academy of Physician’s Assistants rejected the AMA’s claims that PAs provide poorer care (Bailey & Madara, 2020).

Low-level practitioners, such as healthcare personnel like senior caregivers, medical technicians, certified nursing assistants, and registered nurses (RNs) who are not permitted to independently prescribe treatment, are also in shortage. The situation for nurses is representative of the situations that other low-level practitioners face. Proposed responses to the nursing shortage include streamlining nursing education, promoting a more optimal distribution of nurses, improving retention of nurses, and reforms to nursing standards of care.

The American Nurses Association (ANA) is the largest professional nursing organization in the US. The ANA advocates for policies that promote an increase in the supply of new nurses and the retention of practicing nurses. In a letter to the Secretary of the US Department of Health and Human Services (HHS), the ANA (2021) urged him to declare nurse staffing shortages a national crisis, and proposed that the Biden administration “adopt new payment methodologies that recognize the value that nurses bring to patient care” (2021). The ANA also successfully lobbied Congress to appropriate more funds towards nursing education programs in Title VIII of the CARES Act (2020a). A major grant program in Title VIII allocates funding for nurses who

“provide direct care for the elderly, to support geriatric nursing curriculum, to train faculty in geriatrics, and to provide continuing education to nurses who provide geriatric care” (2020a).

The ANA (2020b) urged CMS to expand telehealth care permanently, asserting that “telehealth delivery models ... are appropriate for the post-pandemic environment, and can be expanded further, to improve access not only in rural areas, but in appointment-shortage urban and suburban areas as well.” a

Trade associations in the for-profit nursing home industry, such as the Florida Health Care Association (FHCA) have advocated for more relaxed nursing home staffing standards. Backing a state bill (HB1239) that would reduce the required minimum hours of care delivered by certified nursing assistants per patient in nursing homes, the FHCA’s CEO said, “We know Governor DeSantis understands this need, and we strongly encourage him to make this issue a priority by signing this legislation” (FHCA, 2022). The governor approved the bill, which became state law on April 6, 2022. The FHCA (2022) contends that relaxing standards of care in nursing homes will alleviate nurse staffing shortages and ease nurses’ burdens. Under the new standards, specialist care is included with nurse care in the per-patient minimum daily care time requirement. AARP, however, supports increasing federal minimum staffing requirements in nursing homes, warning that staffing shortages in nursing homes are associated with elder abuse and poorer care. The Florida AARP division and the Service Employees International Union, which represents nursing home workers, opposed HB1239, arguing that it would degrade patient care in nursing homes (Saunders & Urban, 2022).

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